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# The Sanitary Disposal of Municipal Waste

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MORSE-BOULGER DESTRUCTOR.
U. S. NAVY YARD, LEAGUE ISLAND, PHILADELPHIA.

# The Sanitary Disposal

of

# Municipal Waste

by the

## Morse-Boulger Destructor Co.

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By WM. F. MORSE,
New York.

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HAUS u GESUNDHEITSTECHNISCHE GESELLSCHAFT M. B. H.
(DOMESTIC AND SANITARY ENGINEERING CO.,)
BÜSCHSTRASSE No. 6, - - HAMBURG,
SOLE AGENTS FOR THE
MORSE-BOULGER DESTRUCTOR
IN GERMANY.

# THE
# MORSE-BOULGER DESTRUCTOR COMPANY.

INCORPORATED UNDER THE LAWS OF THE STATE OF NEW YORK.

---

OFFICERS:

WM. F. MORSE, *President.* FRANK MOSS, *Vece-President.*

GEO. W. ELKINS, *Treasurer.* SAMUEL MARCUS, *Secretary.*

BENJAMIN BOULGER, *Engineer.*

---

This Company owns the Patents of the

**Morse-Boulger Garbage and Refuse Destructor,**

And controls the American rights of the

**Meldrum "Simplex" Destructor,**

**"Beaman & Deas" Destructor,**

**"Wilkie" Destructor Furnace**

Of MELDRUM BROS. Limited, Manchester, England.

---

These destructors in their various forms deal with the entire field of garbage and refuse disposal. In their smaller sizes they are employed for the destruction of the waste of public and private institutions, hospitals, sanitariums, hotels, dwellings, department stores and business establishments of every class.

For the larger disposal work of communities, towns and cities, that destructor is employed which is best suited to the work required. If the production and utilization of steam power is the purpose of the installation the destructor plant will include the use of powerful steam boilers and apparatus for the development of the highest amount of power in the most effectual and sanitary manner.

This Company is prepared to furnish plans and estimates for destructors, for machinery and apparatus for the utilization of refuse, and for appliances and methods connected with every class of sanitary engineering work.

It will contract for their installation direct with municipalities, or with private companies, or individual contractors, and will guarantee workmanship, economy and efficiency in operation, and perfect compliance with sanitary laws.

Address all Correspondence to

**MORSE-BOULGER DESTRUCTOR CO.,**

**39 Cortlandt St., New York.**

79408.

## PREFACE.

Civilization costs—and the higher the civilization the greater the cost. One item in the cost of civilization is the price of cleanliness and cleanliness means health and life, for without it there can be neither life, health or civilization.

Watch a barnacle in a pool of water at low tide. The creature occupies a pearly house with a trap door in the roof. Suddenly the double door opens, and a delicate hand is thrust out. The fingers close upon some invisible food, the hand is withdrawn and the door closed. Later, when we may not be looking, and when this low form of life has been fed, the door will be opened and the wastage thrown out, because the creature obeys the ancient, primal instinct—to be clean.

A city obeys the same instinct, and the greatest problem now before the American people is municipal cleanliness. The wastage of every city must be disposed of every day, or the people perish. Now the key to cleanliness is not a broom—but fire, because heat is the great transformer. Dirt has been described as "matter out of place." A better definition is matter in the wrong form. The only way to keep a city clean is to transform its poisonous dirt into innocent ash. This has long been known, for the people of ancient cities had their sanitary burning places, where, with purifying fires, they tried in some crude way to ward off plagues and pestilence.

We know to-day that modern science and engineering skill have made it possible to transform a valueless menace to life and health into safe and useful materials, having a real commercial value. It is to this important subject the following pages are devoted and the reader is invited to examine all that here follows because it is believed that the facts here presented are correctly presented, and the deductions based upon them will be found to be borne out by practical experience upon a commercial scale.

Two facts stand out in the following pages with convincing clearness—the safe and rapid destruction of waste material of all kinds is a question of temperature, and the work itself can be done at a profit. Everything burns at some temperature. Five pounds of wet kitchen refuse thrown into the cook stove will put out the fire. Five thousand pounds thrown into a regenerative destructor will part with its water in a few moments, and then burn rapidly and be speedily transformed into harmless ash. It is purely a question of the right

furnace and temperature, and what is true of kitchen waste is equally true of every form of wastage from mill, store, house, hotel or hospital.

Perhaps the most striking thing described in the following pages is the fact that, with the admirable methods and systems employed by the Morse-Boulger Destructor Company there is a remarkable production of useful heat available for steam making or for feed-water heating. By the aid of a regenerative furnace, in which the products of combustion from the burning waste are used in an economizer (resembling a blast furnace stove) to heat the air used for combustion in the furnace itself, a far hotter fire with a higher temperature is obtained, better results are reached in destroying the waste, and the increased heat, after it has done its work, is available for other useful work.

Heat is a mode of power. The method used by this company to destroy wastage gives new heat that, in a boiler, will make steam, and steam, through a dynamo, means light, heat and power. These things are commercially valuable. Thus we find the old and annoying question of the disposal of municipal waste can be changed by the methods of the Morse-Boulger Company from a costly and troublesome question in municipal housekeeping into a safe and easy business, profitable to the city and pleasing to the taxpayers.

Best of all, the Morse-Boulger Destructor Company controls patents covering all the best methods of treating wastage of all kinds. It controls furnaces, machinery and appliances that have stood the severe test of practical experience in many European cities and that have been commercially successful upon a large scale through many years of efficient and satisfactory service.

CHARLES BARNARD.

New York City.

THE MORSE-BOULGER DESTRUCTOR AT MANILA, PHILLIPINE ISLANDS.

## I.

## THE MORSE-BOULGER GARBAGE AND REFUSE DESTRUCTOR.

The Morse-Boulger Destructor is the perfected result of twelve years of experience in the work of garbage and refuse disposal in this country. It is sanitary in operation, convenient in arrangement and durable in construction. In design it preserves all the features that have been found absolutely essential to a furnace of this character. It can be adapted to the disposal of any class of waste that fire will burn, and it will employ any kind of fuel in this process. The destructor is economical in operation, can be constructed at a cost no greater than that of other furnaces of equal capacity, and may be designed for the utilization of the heat, if desired.

In appearance the destructor resembles the usual form of rectangular furnace commonly known as the American type of garbage crematory. Its width and height are each approximately one-third of its length, and it has a brick or iron stack of appropriate length, or may be connected with any chimney already in place.

On the top are charging holes, through which the furnace is fed, and on either side are the usual stoking and ash-pit doors. At the front end is the main fire-box, and a secondary fire-box is provided at one side. The interior comprises one upper main garbage-chamber, extending nearly the length of the furnace, and floored with transverse arched grates of fire-brick.

A second series of grates is placed below the first set. There are vertical openings left between each set of arches, which provide for the passage of the ashes of the material destroyed. At the end of each series of grates are flue openings which provide admission to the lower chamber.

The secondary fire-box, for the combustion of the gases and smoke, is placed at the end of the lower, or second series of garbage grates. Across the rear of the furnace is a combustion chamber divided by a checkerwork of fire-brick. From this combustion chamber flue connections lead to the boiler on the top of the furnace and to the chimney, or smokestack, each of these openings being controlled by heavy fire-brick dampers.

The operation of the destructor is as follows: The fire is first lighted in the secondary fire-box next the combustion chamber, and this space and the dividing checkerwork brought to a high temperature.

The garbage is deposited through the charging holes upon the drying hearth and the upper set of grates; the more combustible portions being placed at the front end in or over the fire-box, and a considerable part of the garbage stoked down to cover the second, or lower set of garbage grates.

Passing over and through the waste the flames from the main fire quickly dissipate the moisture and dry the material, which is drawn down to the fire-box and becomes fuel for drying and burning another charge.

DISPOSAL STATION
KING'S COUNTY INSTITUTIONS, BROOKLYN.

The heat and flames from the primary fire pass the length of the furnace over the charge of garbage deposited upon the bars, and return underneath the upper set of bars and over the second set, igniting and destroying all material thereon, and finally returning under the second set of grates.

The products of this incineration, aided by the heat from the secondary fire, pass into the combustion chamber, and in this heated state are drawn against and through the fire-brick grid, and the carbon-dioxide resulting discharged into the chimney, or carried by the by-pass to the boiler. The ashes fall through the lower set of grates and are removed through the ash-pit doors of the lower chamber.

When the furnace is started and attains the necessary temperature little, if any, additional fuel is needed as long as the garbage is supplied for consumption, unless an unusual amount of moisture is present.

This operation of the destructor is uniform in the various sizes. Each one is provided with the secondary fire-box, an indispensable adjunct for the suppression of gases and fumes of combustion.

Because of its sanitary operation the destructor can be placed in buildings and localities in immediate proximity to large numbers of people and the thickly settled portions of communities.

Since it can be adapted to the disposal of almost any kind of worthless matter, and installed in any locality, it is in demand for many varied uses, which it is the purpose of this catalogue to describe.

---

## II.

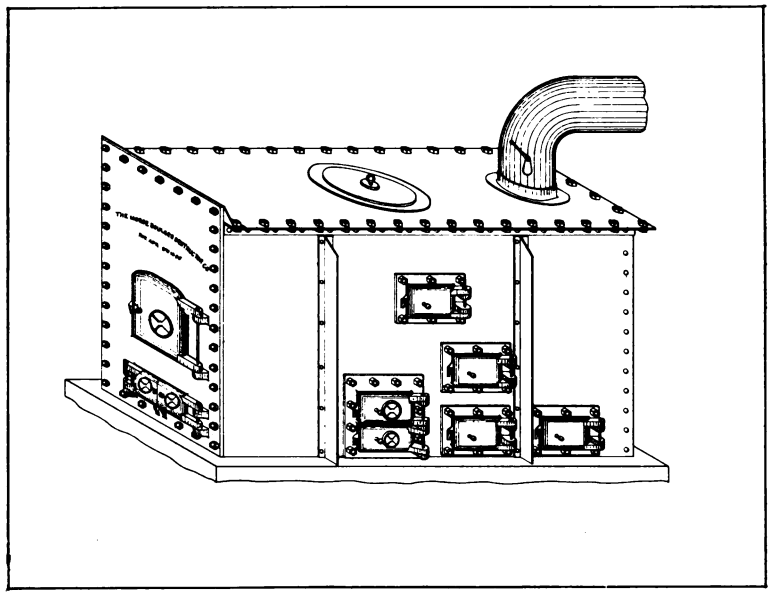
## INSTITUTIONAL DESTRUCTORS.

Public institutions, hospitals, sanitariums and asylums were among the first to recognize the value of waste disposal by fire, and to adopt destructor furnaces.

The advantages gained by the destruction of waste upon the premises without nuisance and with rapidity and economy are so obvious that many of the leading institutions have adopted the Morse-Boulger Destructor as part of the necessary equipment of the building.

This furnace is peculiarly well adapted to the work, as it can be built in shapes and dimensions conforming to the ground space available; can be connected with boiler breeching or smokestacks of any reasonable size; will burn any kind of fuel, and, in its most powerful forms, will destroy infected organic matter which has heretofore been disposed of with great difficulty.

The smaller sizes, from No. 00 to No. 7, may be built with an exterior steel casing of one-fourth-inch boiler plate, solidly joined at the angles and provided with convenient openings for charging, stoking and removing ashes.



MORSE-BOULGER DESTRUCTOR, STANDARD NO. I.

DESTRUCTOR AT ST. LUKE'S HOSPITAL, NEW YORK CITY,
AFTER TEN YEARS USE.

When unusually refractory organic matters are to be destroyed the destructor is fitted with a special gas or oil-burning apparatus, which develops the highest destructive heat in the shortest time and within the smallest space.

In the larger sizes these destructors are employed for the disposal of the waste of groups of buildings belonging to the public institutions of states, counties and cities. These installations are usually separate and independent constructions, equal in size and capacity to the plant required by a community of five thousand to eight thousand people.

For convenient reference these institutional destructors are classified according to size and capacity as follows:

| | No. | Lgth. | Ht. | Wdth. | Example. |
|---|---|---|---|---|---|
| Special | 00 | 3 ft. 2 in. | 2 ft. | 3 ft. | Private Bacteriological Laboratory. |
| Special | 0 | 6 ft. | 4 ft. | 2 ft. 6 in. | Pathological Laboratory, City Hospital, Boston, Mass. |
| Standard | 1 | 7 ft. | 4 ft. | 2 ft. 4 in. | Burbank Hospital, Fitchburg, Mass. |
| Standard | 2 | 9 ft. | 5 ft. | 4 ft. | Homeopathic Hospital, Brooklyn. |
| | 3 | 10 ft. | 6 ft. | 5 ft. 3 in. | Montefiore Sanitarium, Bedford, N. Y. |
| | 4 | 12 ft. | 6 ft. | 5 ft. 3 in. | Cornell Medical College, New York. |
| | 5 | 15 ft. | 8 ft. | 5 ft. 3 in. | Pennsylvania Hospital, Philadelphia. |
| | 6 | 17 ft. 6 in. | 7 ft. | 6 ft. | Bellevue Hospital, New York. |
| | 7 | 20 ft. | 8 ft. | 8 ft. | Kings County Institutions, Brooklyn, N. Y. |

## OTHER INSTALLATIONS IN PUBLIC INSTITUTIONS.

Brookline Hospital, Brookline, Mass.
Milford Hospital, Milford, Mass.
City Hospital, Boston, Mass.
Private Bacteriological Laboratory, New York City.
Homeopathic Hospital, Brooklyn, N. Y.
Kingston Avenue Hospital, Brooklyn, N. Y.
Consumptives' Home, Brooklyn, N. Y.
New York Hospital, New York City.
St. Luke's Hospital, New York City.
University of New York, New York City.
Lying-in Hospital, New York City.
General Disinfecting Station, New York City.
Mt. Sinai Hospital, New York City.
Hudson County Institutions, Jersey City, N. J.
University of Michigan Medical School, Ann Arbor, Mich.
Woman's Hospital, Philadelphia, Pa.
Municipal Hospital for Contagious Diseases, Philadelphia, Pa.

III.

## DESTRUCTORS FOR HOTELS, APARTMENT HOUSES AND BUSINESS ESTABLISHMENTS.

One very striking and important use of the Morse-Boulger Destructor is in the disposal of the waste of great hotels and business establishments, which is enormous in quantity and often perplexing to deal with in bulk.

SPECIAL MORSE-BOULGER DESTRUCTOR,
PENN. R. R. STATION, BROAD AND MARKET STS., PHILADELPHIA.

The addition of a destructor to the usual machinery plant of a large establishment adds but little to the general expense, and provides an efficient and reliable means of dealing with the waste.

Since the economical destruction of waste demands that every item of saving shall be taken into account, it is possible to add to the destructor means of employing the heat developed by connecting with the steam boilers of the building, or with an economizer, or by installing an independent boiler with the furnace.

The Morse-Boulger Destructors installed in some of the largest business houses in New York and Philadelphia have demonstrated their value as auxiliary for the production of steam power in several ways.

A special instance is the installation of a destructor in connection with an economizer, or feed-water heater, in a great department store in Philadelphia.

The refuse is brought from all the floors of the building through a large chute into a room adjoining the destructor, and fed continuously into the charging-hole of the furnace. An underground flue connects with a Green's Economizer, which in turn connects with the chimney, and the heat of the destructor raises the temperature of the feed-water for the boilers of the establishment to 240 degrees to 260 degrees.

The saving in fuel is 15 per cent. of the whole quantity of coal

MORSE-BOULGER DESTRUCTOR AND GREEN'S ECONOMIZER
IN LIT BROS. DEPARTMENT STORE, PHILADELPHIA.

THE DESTRUCTOR AT LEAGUE ISLAND, PHILADELPHIA
INTERIOR OF HOUSE.

formerly burned, and if to this be added the former expense of taking away the waste, the economical working of the combined installation can easily be determined.

In the new Hotel Astor, on upper Broadway in New York City, a destructor has been installed which has its own independent steam boiler. This destructor has a capacity of five tons of garbage and refuse daily, and the heat developed by the destruction of this material will maintain a continuous steam power available for any purpose of the establishment.

Another special use of the Morse-Boulger Destructor is shown in the installation in the annex of the Broad Street Station of the Pennsylvania Railroad, Philadelphia.

Here there is a daily quantity of more than one cubic yard of cancelled tickets to be destroyed, besides the office waste from the large force of employees.

The waste is brought by chute from the top story of the building and discharged into the destructor, which is provided with a special locking device for securing the doors and other openings during combustion, as the cancelled tickets, bonds and other important business papers are destroyed as a precaution against duplication or reissue.

In all these installations the principles of construction and the operation of the furnace are the same, except that in the largest, provision is made for forced draft under the ash-pit if required.

Among the latest are:

Macy's Department Store, New York City; in connection with steam boiler.

Snellenburg's Department Store, Philadelphia; in connection with steam boiler.

Lit Bros.' Department Store, Philadelphia; in connection with economizer for heating feed-water.

New Hotel Astor, New York City; with independent boiler.

Pennsylvania Railroad Station, Broad Street, Philadelphia; special destructor for paper refuse.

Hotel Bellevue-Stratford, Philadelphia
Hotel Belmont, New York City
Hotel St. Regis, New York City
Hotel Knickerbocker, New York City } Under construction.
Hotel Imperial, New York City
Manhattan College, New York City
New Hotel, Saratoga, N. Y.

New Hotel Sturtevant, New York City.

Hotel Martinique, New York City.

Sailors' Snug Harbor, Staten Island, N. Y.

Apartment houses in New York City, Philadelphia, Pittsburg and Chicago.

The United States Government has adopted the Morse-Boulger Destructor for several of the army and navy stations, and for the special requirements of other departments of the Government at

Navy Yard, League Island, Philadelphia.

Navy Yard, Brooklyn, N. Y.

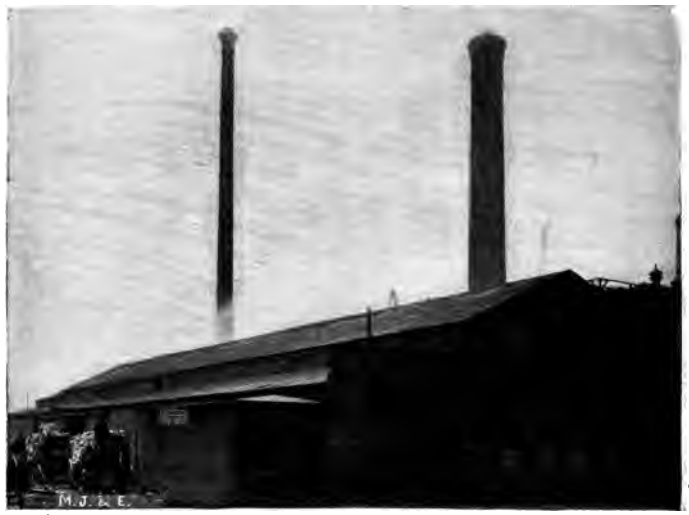
Fort McPherson, Atlanta, Ga.

Fort Banks, Winthrop, Mass.

Marine Hospital Service, Washington, D. C.

United States Immigration Station, Ellis Island, New York Harbor.

United States Army Sanitarium, Fort Bayard, New Mexico.



THE REFUSE UTILIZATION STATION, BOSTON.

THE RECEIVING ROOM AND CONVEYOR, BOSTON.

## IV.

## THE UTILIZATION OF MUNICIPAL REFUSE.

The proportion of refuse, or rubbish, in all municipal waste is nearly 20 per cent. of the whole. Usually this is collected with ashes, taken to dumps, and roughly sorted over by persons who recover a portion of it in a condition of filth, and the remainder left to be consumed by fire in open air, or scattered by the winds.

The largest item in refuse is paper, which in its various forms comprises 60 per cent. of the whole. There is also a large proportion of cardboard, rags, leather, iron, glass, and corks and twine, all of which is salable if recovered in a condition reasonably free from dirt.

The value of this recovered refuse was determined by experiments made in New York City by Colonel Waring, and still more completely demonstrated by the work of the Refuse Utilization Station and the Morse-Boulger Destructor, built in Boston by members of this company in 1898-1899.

The Disposal Station is a building one hundred and sixty-two feet long, eighty feet wide, with brick walls and steel columns supporting a wooden roof. There is a sub-basement under one-half of the building containing the baling presses and destructor.

A large storage space is provided for receiving the waste; the carts discharging with no delay, except for weighing each load. From this storage space the rubbish, with a little preliminary sorting to remove the heavier articles, is placed on an endless belt or movable iron platform four feet wide and one hundred and fifty feet long, which carries it slowly toward the other end of the building. On each side of this moving conveyor stand files of men, who pick out the several grades of paper, rags, cardboards, etc., and place in bins behind them. The bottom of these bins discharge into presses driven by power placed in the basement, which press the paper and rags into bales of 600 pounds. The other articles—glass, iron, leather, twine, etc.—are also removed to separate bins.

The portions of refuse remaining on the conveyor not worth saving pass up an incline and are discharged through a chute in a continuous stream into the Morse-Boulger Refuse Destructor placed across the rear end of the building, everything worthless being burned without delay and with no rehandling or storing. This destructor is of special and peculiar type built with interior walls of fire-brick blocks, with heavy exterior walls solidly bound with buckstays and tie-rods, provided with sliding fire-clay cover for the feed holes, and doors for removing clinker and ashes.

At the rear end is a 60 H. P. boiler, with independent fire-box, but operated solely by heat from the destructor, and furnishing power for moving all the machinery for sorting and baling, operating a dynamo for lighting the building by electricity (ten arc lights and

POWER AND HAND PRESSES, BOSTON.

THE MORSE-BOULGER DESTRUCTOR.
REFUSE UTILIZATION STATION, BOSTON.

thirty incandescent) and heating it in winter. No fuel has ever been used except the refuse, and but a portion of the power developed is employed. A boiler of 125 H. P. can be maintained at its maximum capacity by the heat from the destructor. The draught is regulated by heavy fire-clay dampers, the surplus heat going through a by-pass to the chimney—a steel self-supporting shaft one hundred and forty feet high, lined with fire-brick.

The daily quantity of refuse collected in four and one-half years from the district, which includes about ninety-five miles of streets and contains approximately 200,000 persons, is shown in the following table taken from the official reports of the Sanitary Division of the Department of Streets of the city of Boston, for the years named:

| | Number of loads. | Weight per load. Pounds. | Tons. |
|---|---|---|---|
| 1899..... | 16,926 | 796 | 6,736 |
| 1900..... | 16,423 | 1,045 | 8,581 |
| 1901..... | 17,585 | 1,045 | 9,188 |
| 1902..... | 16,684 | 1,045 | 8,717 |
| 1903 (estimated).. | 17,000 | 1,045 | 8,882 |

The collection includes everything in the shape of miscellaneous refuse, or rubbish, and the many useless and worthless articles from houses, stores and factories. The exact figure of the percentage of marketable matter is not available, but, as estimated by competent authorities, is as high as 70 per cent. of the whole. Taking the yearly collection for 1901, reported at 9,188 tons, then 6,431 tons represents the marketable portion, and 2,757 tons the combustible portion, or that available as fuel.

The operation of this destructor, together with the results of experiments in refuse incineration made in New York City under the direction of the Commissioner of Street Cleaning, shows that the average calorific value of one cubic yard of combustible refuse is equivalent to the evaporation of sixty pounds of water, or 2 horse-power steam. Since the average daily amount collected and disposed of in Boston at the Utilization Station is equivalent to thirty tons per day, or three hundred cubic yards, it follows that the calorific value would be equal to the development and maintenance of 125 horse-power for twenty-four hours.

But the value of 70 per cent. of sorted refuse, when sold at the average market price for old paper, is very much more than its equivalent in coal. It appears, therefore, that the most economical management of a Municipal Refuse Disposal Plant would be the recovery of all salable portions of the city refuse, and the conversion into steam of the remainder to be turned to many municipal purposes, such as pumping water or sewage, for electric lighting, for steam disinfection, and other uses.

The operation for four and a half years of this refuse destructor in Boston is a striking and successful demonstration of the fact that in all the large cities of this country the combustible refuse, or rubbish, of the city, which is almost invariably thrown away with the ashes, is of sufficient value to warrant the construction of a special Refuse Station for the recovery of marketable portions and the conversion of the remainder to steam power.

The city of Buffalo, N. Y., has accepted the designs and plans of the Morse-Boulger Destructor Company for a Refuse Utilization Station, to be located on city ground, in what is known as the Hamburg Canal Strip. This is very nearly in the geographical center of the city, accessible from every point for the reception of the waste, which is brought to the station from all sections, and is estimated at thirty tons per day.

The destructor will be upon the same general lines as the one employed in Boston, although some changes will be made from the exigencies of the situation. The heat will be used to operate steam boilers of 125 horse-power in the adjoining sewage disposal station. Thus the city is to have its combustible refuse cared for in a sanitary way and produce steam power for its own use from the combustion of the worthless portions of the rubbish.

It is estimated that the saving for the city arising from the utilization of the heat, the saving in the transportation of the material, and the actual cost heretofore incurred in caring for the dumps where this rubbish was deposited will amount to $10,000 per year.

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RIVETING UP THE STEEL SMOKE-STACK, MANILA.

## V.

## THE MUNICIPAL WASTE OF MANILA AND ITS DISPOSAL BY THE MORSE-BOULGER DESTRUCTOR.

The recent adoption of the Morse-Boulger Destructor for the disposal of the waste of Manila, Phiippine Islands, marks an era in the history of American crematory development.

The United States Provisional Government having issued specifications offering opportunities for the presentation of any type of destructor furnace in the world received five proposals from English and American furnace builders. The plans presented by the Morse-Boulger Destructor Company were accepted, and a contract was made for the installation of a destructor having a capacity of one hundred and thirty tons of mixed city waste, refuse and garbage, per day of twenty-four hours.

Many extraordinary obstacles were encountered in this construction. All building materials had to be sent from the United States,

SETTING UP THE DESTRUCTOR IRON WORK, MANILA.

SIDE OF DESTRUCTOR, MANILA.

CHARGING HOLES ON TOP OF DESTRUCTOR, MANILA.

native labor had to be procured and trained, and climatic conditions and the character of the foundation offered extreme difficulties.

Within six and a half months from the date of contract a destructor forty-five feet long, twelve feet high and eleven feet wide, with a steel stack one hundred feet high and a 50 H. P. boiler, was installed in a house made of a steel frame and covered with corrugated iron, fifty feet by sixty feet in area.

The foundation was upon piles driven into the marshy soil of the site, and this necessitated raising the structure six feet above the normal grade. An extensive approach, or inclined platform, was provided by the Government, and the destructor has gone into effective operation, destroying all the miscellaneous garbage and refuse supplied by the city.

The foregoing offers an illustration of the uses of the Morse-Boulger Destructor for the incineration of mixed city waste, aided by forced draft obtained from the steam boiler power.

The same apparatus, operated in a similar manner, will be found equally efficient for the disposal of miscellaneous city refuse and garbage at any point in this country.

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THE DESTRUCTOR AND STEEL FRAMING OF HOUSE, MANILA.

## VI.

## THE PRODUCTION OF STEAM POWER FROM MUNICIPAL WASTE.

The first purpose of a refuse destructor is to dispose of the effete matter of a city with efficiency and economy, and to do so without the emission of offensive odors and smoke.

It is a well-established fact that to do this work in the best way the highest obtainable temperature must be developed and maintained by the destructor. It is also well known that the highest temperature cannot be had except by the introduction of forced draft under the ash-pits of a furnace.

It has been shown in many reports that mixed waste possesses calorific value sufficient to maintain its own combustion continuously, if the destructor is charged and clinkered regularly. It has also been proved that the destruction of city waste in this manner will develop steam power by the evaporation of one-half to two pounds of water for every pound of waste consumed, depending upon the amount of moisture present in the waste, and upon other conditions common to all classes of municipal refuse.

These principles are established by the operation of the English destructors, of which there are a large number in active operation, their work extending over a period of twenty-five years of continuous experiment and development.

Progress in the art of refuse disposal by fire has reached a point in the United States, where, if further advances are to be made, they must be in the direction of economical conservation of the power derived from heat, and the adoption of principles which have been proved by other countries to be thoroughly practical.

In other words, the rapid, efficient and sanitary disposal of large amounts of municipal waste in this country demands that there shall be brought into use the same, or similar forms of destructor furnaces which have been entirely successful in over two hundred cities in other parts of the world.

While the conditions attending the collection of waste in American cities, and the character of this waste are not exactly the same as abroad there is still no radical difference in the material to be disposed of. If due allowance is made for the large proportion of moisture in the garbage, or kitchen waste, against which may be placed the greater proportion of unburned coal in household ashes, and the very much larger proportion of combustible matter in the refuse of American cities, then it will be found that the results obtained from the cremation of the waste of these cities will as a whole be very nearly the same as those obtained by the incineration of English towns' refuse by any one of the best forms of English destructors.

Recognizing the fact that the rational development of this work must be in the direction of the utilization of heat for steam power, and that the rapid production and maintenance of steam power has been better obtained by other than the American forms of destructors, the Morse-Boulger Company, desirous of placing at the service of all the cities in this country the best, most efficient and reliable destructors, has acquired the sole American rights for the construction and installation of the furnaces which are built under the patents of the Meldrum Brothers, Limited, of Manchester, England.

The Meldrum "Simplex" and the "Beaman and Deas" destructors built in the past five years have given this corporation the foremost place in all disposal work. Their destructors are recognized and strongly indorsed in the reports of the very highest sanitary authorities as the most efficient and reliable furnaces known for the disposal of waste and the production and utilization of power.

Their patents cover the construction of several forms of furnaces, each adapted to a different class of work.

The Morse-Boulger Company recommend the use of these destructors for the fullest development of power by the destruction of waste and its employment as auxiliary in many departments of municipal service in this country.

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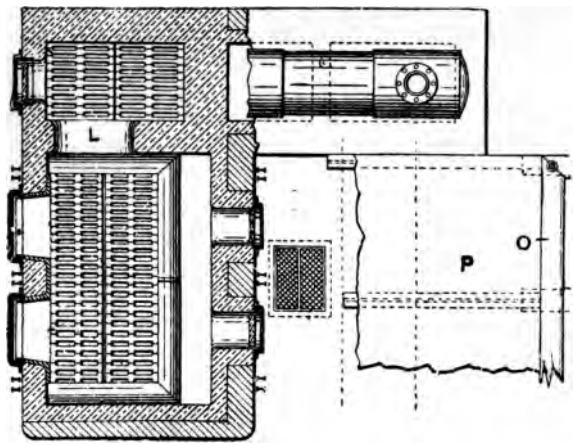
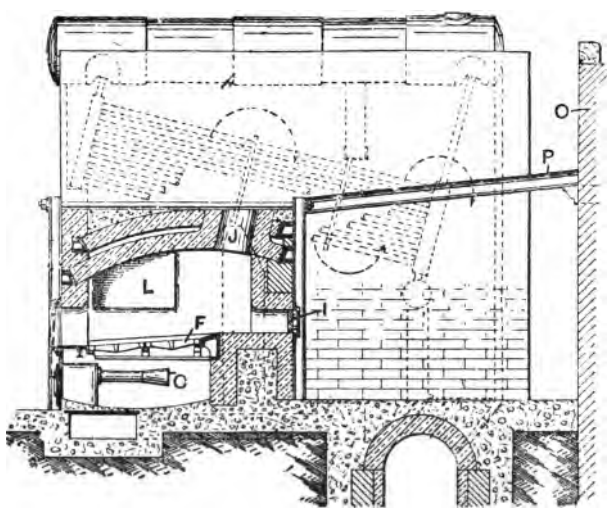
BOILER, ENGINE AND BLOWER, MANILA.




NO. 1. PLAN, MELDRUM "SIMPLEX" TWO GRATE DESTRUCTOR.




NO. 2. CROSS SECTION, MELDRUM DESTRUCTOR.

## VII.

## THE MELDRUM "SIMPLEX" DESTRUCTOR.

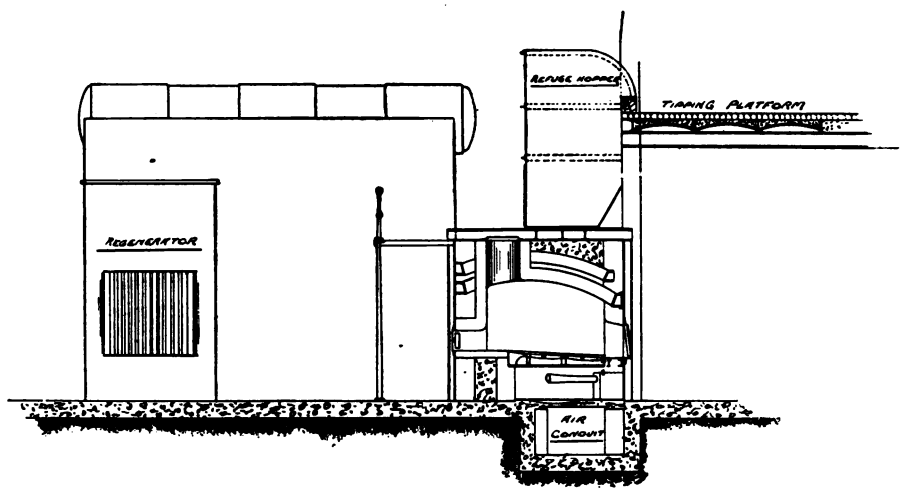
This destructor is a furnace of the modern type, and is wholly original, and novel in arrangement as compared with other destructors. It combines efficient, inoffensive cremation of refuse with the production of a maximum amount of steam power.

The furnace is practically one long cell, fed and clinkered through two, three or four separate openings, according to the number of grates installed.

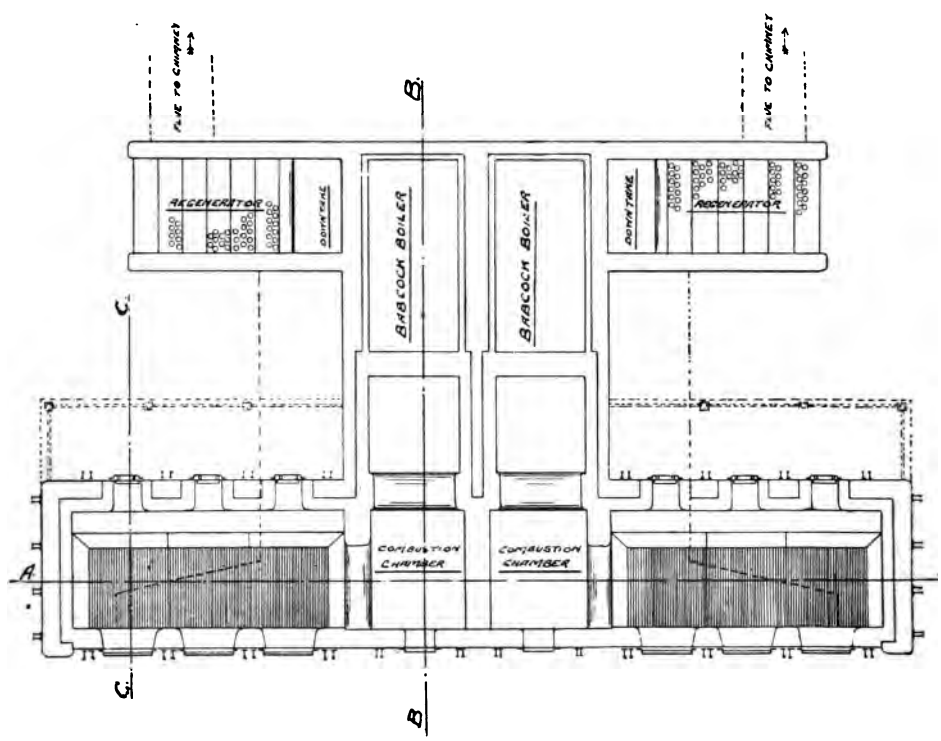
The grates are arranged side by side, separated by dead-plates. The ash-pit is divided into sections corresponding with the grates above, and each section is closed by air-tight doors. In this closed section of ash-pit, beneath the grate, are placed patent steam blowers, which deliver any desired pressure of forced draft up to six inches of water column, the average blast used being one-fifth inch of water.

The charging of this destructor is done by hand-feeding through the fire-doors, or through charging-holes on the top of the furnace, as shown in Fig. 2. The several grates are charged and clinkered in rotation, the gases and smoke from any one of the freshly charged grates are rendered innocuous by the action of the others, which remain at high temperature. If grate No. 1 be charged in small quantities immediate ignition of the material is secured and the gases as distilled in their sideway motion must pass over and intermingle with the heated volume passing from Nos. 2, 3 and 4, the whole volume then entering the combustion chamber. This combustion chamber has a temperature of 1,800 degrees to 2,700 degrees Farenheit, which insures the perfect combustion of the vapors and products of cremation. After passing through the boiler the hot gases are utilized in heating the air force under the grates by means of an econometer or regenerative air heater, placed in the flue beyond the boiler. The temperature of this air, raised to 300 degrees Fahrenheit, and supplied under the grates at a pressure of one and five-tenths inches water column insures the rapid evaporation of all liquids and is a most important factor in the destruction of all combustible matter, the production and maintenance of the highest obtainable temperature and the development of the greatest amount of steam power.

The design and construction of the Meldrum "Simplex" destructor is shown in the plates. Figures 1, 2 and 3 are plans and sections of a two-grate Meldrum destructor with a Babcock and Wilcox water tube boiler, showing tipping platform, charging-holes, stoking and clinkering doors, steam and air blasts under the grates, and continuous fire-grates, with separate ash-pits. Fig. 4 shows the plan of two Meldrum destructors of three grates each, with separate boilers and econometers, but with the same platform and chimney. This is a very powerful and




NO. 3. REGENERATOR, TIPPING PLATFORM, TOP CHARGING HOLES, BOILER, AIR BLAST, ETC.




NO. 4. PLAN OF TWO THREE GRATE MELDRUM DESTRUCTORS WITH STEAM BOILERS AND REGENERATORS.

compact arrangement, and the destructor plant has a daily capacity of one hundred and twenty tons of miscellaneous city waste, developing upward of 500 horse-power.

A Meldrum "Simplex" destructor of ninety square feet surface consumes fifty pounds of refuse per hour per square foot of grate. This capacity is adequate for a population of 50,000, producing a total of fifty tons of refuse per day.

The work of this destructor is best illustrated by reference to a few examples.

Rochdale, England, with a population of 72,000 has four "Simplex" grates, with two Lancashire boilers. The refuse consists of the ordinary mixed collection, and it is consumed at the rate of fifty-three to sixty-six pounds per square foot of grate surface per hour. The destructor evaporates from one and one-half to two pounds of water for every pound of refuse destroyed, and develops 350 horse-power in steam. The cost of burning is twenty cents per ton (2,240 pounds) for labor and supervision. About 30 per cent. of the whole amount consumed is ash and clinker and this is manufactured into mortar and used for various municipal purposes. This destructor is separated from adjoining houses by the width of the street only.

The heat from a destructor may be utilized for the production of electricity, and this applied to many municipal purposes.

At Darwen, England, a four-grate Meldrum destructor of one hundred and four square feet of grate surface, with two steam boilers, thirty feet by eight feet, and a regenerator for heating air for combustion, has been installed.

The following is the official report of the test made in 1899:

| | |
|---|---|
| Duration of test | 48 hours (continuous) |
| Nature of refuse—unscreened ash-pit refuse, 61.88 tons; slaughter-house and fish-market offal, 2 tons; average percentage of moisture, 35%. | |
| Total quantity of refuse destroyed | 63.88 tons |
| Total weight of clinker residue | 19.5 tons (30.6%) |
| Temperature of feed water, average | 185° Fahr. |
| Water evaporated per pound of refuse, actual | 1.48 lb. |
| Water evaporated per pound of refuse, from and at 212° | 1.55 lb. |
| Average steam pressure per square inch | 183 lbs. |
| Average temperature of combustion chamber | 1,633° Fahr. |
| Highest temperature of combustion chamber over (copper melted five times) | 2,000° Fahr. |
| Lowest temperature of combustion chamber | 1,201° Fahr. |
| Average temperature of flue after leaving boilers | 703° Fahr. |
| Average temperature of flue after leaving regenerator | 585° Fahr. |
| Average temperature feed air from regenerator | 328° Fahr. |

The average calorific value of this refuse is one-fifth that of coal of the ordinary quality, or $1.20 per ton, coal being at $6 per ton.

For the year 1901 the average evaporation per pound of refuse was 1.25 pound of water, taken over a total quantity of 10,000 tons of refuse.

The result of the destruction of refuse in this manner is electrical

THE MELDRUM "SIMPLEX" DESTRUCTOR, WALKER-ON-TYNE, ENGLAND.

power which is applied as auxiliary to the City Electric Station, and provides a service capable of supplying 400 horse-power for twelve hours each day, or 260 horse-power for eighteen hours, equivalent to an annual production of 900,000 kilowatts.

Figures 5, 6 and 7 show the cross sections of destructor, plan of grates, air-duct and side of destructor.

The installation of the Meldrum destructor at Nelson, England, is an example of one of the most successful destructors in modern practice, as is shown by the following official report:

RESULT OF TEST, DECEMBER 20, 1900, NELSON.

| | |
|---|---|
| Number of grates | 4 |
| Area in square feet | 100 |
| Steam boiler, 30 feet by 8 feet | 986 sq. ft. |
| Refuse consumed | 54,180 lbs. |
| Per hour | 5,703 lbs. |
| Per square foot of grate per hour | 57 lbs. |
| Water evaporated per pound of refuse | 1.5 lbs. |
| Steam pressure | 118 lbs. |
| Average temperature combustion chamber 17 readings | 2,200° Fahr. |
| Highest temperature | 2,650° Fahr. |
| Ash-pit pressure | 1.85 water |
| Percentage of clinker remaining | 21.18 |

The steam power is now employed in electric lighting, driving a pump and a mortar mill, grinding stable food and providing steam for the City Steam Disinfecting Station.

In November, 1902, a Meldrum destructor of two units of four grates each, with two boilers and regenerators, was installed at Walker-on-Tyne.

After the official test on November 28 by the Messrs. Handcock & Dykes, Consulting Engineers, their report to the city was, in part, as follows:

"It will thus be seen that practically thirty-one tons were consumed in eleven hours for one shift of three men, at a cost for wages of 6¾d. per ton consumed, and that with another shift of three men, sixty tons could easily be burnt in twenty-four hours with one unit, the whole plant thus being capable of consuming over one hundred and twenty tons every twenty-four hours, with the exception, of course, that periodically one unit would be laid up for cleaning and overhauling.

"The result, therefore, of the test reflects great credit on all concerned, and the Council are to be congratulated upon obtaining a higher efficiency from the destructor that Messrs. Meldrum guaranteed, a circumstance which must convey complete satisfaction to those who have been connected with the construction of the plant.

"With the result of the test we are exceedingly pleased, as the plant has in every respect exceeded the requirements that we specified, and is working in a most satisfactory manner, there being no offensive gases given off, either from the chimney or the furnaces, and there is almost an entire absence of smoke. It seems, however, a great pity to an engineer, or, indeed, to any one of an economical turn of mind, to see so much valuable power being wantonly thrown away, as the present plant has no arrangement for steam raising on a large scale.

We were unable to test the amount of water which could be evaporated per ton of refuse, but from our experience of the other destructors, and heat obtained in the furnaces, we have no hesitation in asserting that if suitable boilers were inserted, each pound of refuse burnt in the destructor would provide one and one-half pounds of high pressure steam over and above that required for the steam jets, etc. Now, each unit burns two and nine-tenths tons of refuse per hour, thus furnishing practically 10,000 pounds of steam per hour, and allowing say twenty pounds of steam per horse-power per hour would give 500 horse-power, which is considerably more than the power required to do all the lighting in Walker, and supply the trams, in addition. This is a sufficient answer to the critics who questioned the original proposals submitted, namely, to work the machinery in your proposed electric lighting station entirely by the heat provided by the refuse destructor.

"We believe that their coal consumption at the present time is approximately two and one-half pounds per horse-power per hour, so that this 500 horse-power represents 1,250 pounds of coal per hour for twelve hours a day, or 2,444 tons per annum, costing say £1,100. In other words, there is being thrown away in your destructor heat representing £1,100 per annum."

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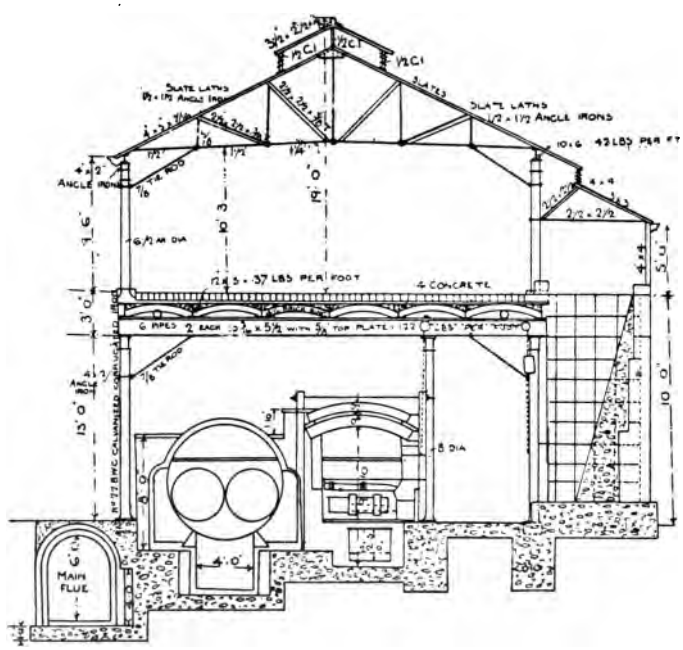



CROSS SECTION OF DESTRUCTOR HOUSE.

## VIII.

## THE BEAMAN AND DEAS DESTRUCTOR.

The Beaman and Deas destructor is a modern, high-temperature furnace, introduced about six years ago, and now in successful operation at many places.

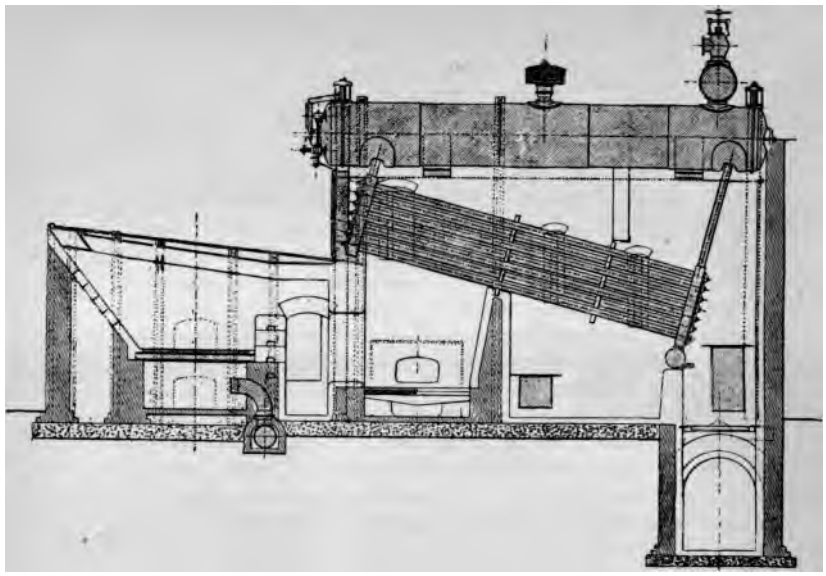
From Fig. No. 5, which illustrates the furnace as installed at Leyton, the essential features of this destructor may be observed. These include a level fire-grate, consisting of simple type stationary bars; a fire-brick hearth, carried on girders and sloping at an angle of about twenty-five degrees; a high-temperature combustion chamber at the rear of the furnace and common to each pair of cells; a closed air-tight ash-pit with forced draught; and provision for the admission through small air-ducts of a secondary air supply at the fire-bridge.

The material to be burnt is carted up a short incline to the top of a platform measuring about eight feet nine inches above the ground level, and is tipped direct over a hopper mouth about one foot six inches square, through which it is pushed on to a fire-brick hearth carried on T-irons, as shown in the accompanying illustration. At the bottom of the inclined hearth the refuse is received upon a fire-grate area five feet square, which is fixed level at a height of about two feet nine inches above the floor of the ash-pit. The grate bars are of the ordinary stationary types, and are to be preferred to movable bars. They have spaces between them of only three-thirty-seconds of an inch, and the weight of fine ash passing through from a week's work of five days, and burning about one hundred tons of refuse, only amounts to about three and one-half hundredweights.

Vertically under the fire-bridge, between the furnace and the combustion chamber, is an air culvert, on the top of which are the air-blast pipes. These pipes are usually about twelve inches in diameter, and discharge into a hermetically closed ash-pit immediately under the fire-bars.

Air-draught is used, and is supplied from fans at a pressure of about two inches of water, and is regulated by the use of baffle valves worked by handles on either side of the furnaces, convenient for the stoker in attendance. The forced draught tends to keep the bars cool, and to thereby prolong their life.

The vapors given off by the charge drying on the sloping hearth pass through the fire, directly over the fire-bars and over the fire-bridge. The bridge is perforated longitudinally with air-passages, which may be observed by reference to the figure. The miniature flues or air-passages lead from a grated opening on the face of the brickwork outside near the lever for regulating the draught. The air passing through the hot ducts creates a strong draught, and the air in the course of its passage becomes heated, is discharged near the top



LONGITUDINAL SECTION, NO. 5. BRAMAN & DEAS DESTRUCTOR WITH STEAM BOILER, AIR BLAST, ETC.

of the bridge, and thus meets the fumes passing over into the combustion chamber, and furthers their more perfect combution by means of this auxiliary supply of heated oxygen; the principle of the action being, in fact, somewhat similar to that of the Bunsen burner.

The combustion chamber, which attains an exceptionally high temperature, is provided with large iron doors at each end for the admission of infected or other articles, and also for access for periodical removal of the fine ash from the flues. In order to utilize the high temperature attained, a boiler is usually provided to each pair of cells. The boiler shown in the figure is a water tube boiler of Babcock and Wilcox type, and is heated by the gases from the combustion chamber, which pass on their way to the main flue three times between the boiler tubes. A secondary furnace is provided under the boiler for raising steam with coal fuel when the cells are not in use.

The cells are, of course, to be worked in pairs. When one cell is being recharged with fresh refuse, and its temperature is low, the adjoining cell is at full red heat. Both cells discharge into one combustion chamber common to the pair, so that the heated gases from the hotter cell maintain the temperature of the combustion chamber, and so assist to thoroughly cremate the gases from the refuse in the other cell undergoing recharging. When properly managed, a fairly uniform high temperature is thus maintained in the combustion chamber, preventing the escape of obnoxious vapors.

The action of the forced blast in the furnace throws up showers of small clinker particles, which fix themselves upon the roof of the cell in a stalactitic form. This coating covers the fire-brick lining of the

cell, and protects it from the action of the great heat. The stalactites obtained from the crown of the arch consist principally of silica, alumina, oxide of iron, lime, magnesia, etc.

The Beaman and Deas destructor will properly consume about twenty tons of house refuse per cell for twenty-four hours, or about seventy-five pounds of refuse per square foot of grate area per hour, each cell having an area of twenty-five square feet of grate. At Llandudno, where this type of furnace has recently been laid down in conjunction with an electric lighting station, the amount of refuse burned per hour per square foot of grate area is seventy-one and seven-tenths pounds.

At Leyton a battery of eight cells of this type deals with the house refuse and filter press sewage sludge from a population of over 100,000 persons, and as a rule either four or six cells are in use at the same time.

The material burned is of a most incombustible nature, the pressed sludge containing about 60 per cent. of moisture, and sometimes considerably more. This material, mixed in nearly equal proportions with the house refuse (which also is of a poor calorific value), is burned at the rate of about seventeen tons per cell per twenty-four hours, or about sixty-four pounds per square foot of grate area per hour.

Notwithstanding the incombustible nature of the mixture burned, a considerable amount of steam power is developed, equal to from 35 to 40 i.h.p. per cell per hour, at an average steam pressure in boilers of one hundred and five pounds. The cost in labor of burning this mixture is about 1s. 7d. per ton.

The steam is utilized for pumping low-level sewage, lighting the works by electricity, driving sewage mixers, lifts, etc. No coal is used when the destructor is in use.

Both destructor and sewage works are worked without the slightest nuisance or inconvenience to the neighboring houses, and the ground.
adjoining the site of the works is now being rapidly developed and built upon.

During the year ending March 31, 1899, the destructor consumed 10,741 tons of house refuse and 8,568 tons of pressed sewage sludge cake, making a total of 19,309 tons, or about sixty tons per day. The amount consumed is upward of 3,000 tons more than that burned during the previous year.

The total amount of residue during the year was 5,593 tons of clinker and 485 tons of fine ash, making a percentage of 31.4 per cent. of the material dealt with.

The total cost of labor and materials in working the destructor station for the year was £1,906, of which amount £1,590 was spent in wages. The cost in labor and material of dealing with the house refuse and pressed sludge therefore works out at 1s. 11.7d. per ton. Against this there are important assets in the shape of steam power derived for running the sewage works adjoining, lighting the premises with the electricity, and by the sale of clinker.

A combined destructor and electric lighting plant has been laid down at Canterbury, and commenced working in November, 1898.

The plant consists of two Beaman and Deas furnaces, arranged side by side, fed by a large sloping refuse hopper. There is no inclined roadway, the refuse being raised to the tipping platform by an electric lift. A Babcock and Wilcox boiler, with 1,619 square feet of heating surface, is arranged in the line of the main flue, and close up to the cells, so as to get the full benefit of the heat after leaving the combustion chamber.

With the Canterbury installation, laid down as it is in conjunction with the electric station, the production of steampower from the destructor is of almost equal importance with the cremation of the refuse. Careful tests have therefore been carried out by the city surveyor, and also by the corporation's consulting engineer, to accurately determine the actual performance of the plant in this direction. The first test, conducted by the ctiy surveyor in October, 1899, gave results in steam production.

| Description. | Actual Results of Trial. | Performance guaranteed by Contract. |
|---|---|---|
| Total weight of refuse burned. | 29,400 lbs.=13.125 tons (2,240 lbs.) | 24,500 lbs. |
| Time occupied in cremating the refuse | 8.75 hours | 10.5 hours |
| Refuse cremated per hour | 3,360 lbs.=1.5 ton | 2,800 lbs. |
| Total evaporation | 41,280 lbs. of water | 33,600 lbs. water |
| Rate of evaporation per hour | 4,717 lbs. of water | 2,800 lbs. water |
| Average temp. of feed water | 125° Fahr. | 60° Fahr. |
| Average steam pressure | 132.2 lbs. | 125 lbs. |
| Evaporation per 1 lb. of refuse (actual) | 1.404 lb. water | ..... |
| Evaporation per 1 lb. of refuse (reduced to contract standard of 60° temperature of feed water and 125 lbs. pressure) | 1.32 lb. water | 1 lb. |
| Evaporation per 1 lb. of refuse, from and at 212° Fahr. | 1.59 lb. water | ..... |

The evaporation result obtained—viz., 1.32 pound water—was therefore in excess of the guaranteed amount by 32 per cent. The refuse used in the trial was not selected or in any way sorted beyond the picking out of the large tins. It consisted of the ordinary day's collection, and the weather prevailing at the time was dry and mild. The city surveyor is of opinion that during the dry, cold and frosty weather, the results would surpass the above, while during the summer they would not approach this high efficiency.

The evaporation was at the rate of 4.717 pounds of water per hour; that is, taking twenty pounds of steam per i.h.p. per hour, the destructor is capable, under the conditions of the test, to yield $\frac{4,717}{20}$=235 i.h.p. per hour, and with the exception of the steam used in pumping and heating the feed water and working the forced draught and lift, this power is available for external work in the electric undertaking.

THE BEAMAN & DEAS DESTRUCTOR, DARWIN, ENGLAND.

So high a degree of efficiency in ordinary everyday working is scarcely to be expected as that obtainable on test, and it will be of interest to compare the foregoing results with the following data ascertained over a prolonged period of 200 hours:

In the second test, conducted by the council's consulting engineer, the evaporation result (from and at 60 degrees Fahr.) per pound of refuse was very near that obtained above, but slightly even more favorable. The data obtained as tabulated as follows:

Total refuse delivered and burned estimated at 15.2 cwts. per load...=573,440 lbs.=256 tons.
Time taken to burn above.....=200 hours.
Average rate of burning per hour...=1.28 ton
Total of evaporation (actual).....=552,480 lbs.
Average evaporation per pound of refuse burned.....=.986 lb.

$$\text{Average evaporation per hour.....}=2{,}762 \text{ lbs.}=\frac{276}{2}=138 \text{ i.h.p. per hr.}$$

The maximum load carried by the destructor was one hundred and eight kilo-watts, and the minimum load fifty-three kilo-watts.

The percentage of clinker to the refuse burned amounted to 33 per cent., which is rather a large proportion.

The cost of burning the refuse was 10d. per ton for labor and 6d. per ton for electrical energy used in the process, taking the current at 3d. per unit.

## IX.

## WILKIE'S IMPROVEMENTS IN BEAMAN AND DEAS PATENTS.

These embody all the essential features incidental to the Beaman and Deas system, but involve a few changes in construction.

Briefly summarized, the principal objects aimed at are as follows: (a) To obtain a more perfect combustion of the articles and substances treated; (b) to economize space and thereby reduce cost; (c) to more fully utilize the heat generated in the process of combustion; (d) to provide means for charging the fuel or refuse without handling.

These improved methods are obtained by arranging the fire bridges in juxtaposition; that is, two of the furnaces, or cells, are placed end to end at their fire-bridge ends, sufficient space being left between their respective bridges to form a combustion chamber. Thus the particles forming the gases impinge upon one another, insuring their thorough admixture and fusion.

The temperature in the combustion chamber is proportionately raised, and more heat is available for steam generating purposes. The boiler is placed immediately adjacent to the combustion chamber, so that radiation losses are reduced to a minimum. Means of isolating a pair of cells from its steam generator can be introduced if desired, and the cells can be extended indefinitely in single or parallel series without any intervening space between the units.

The storing and charging apparatus consists of two hoppers, one above the other, the upper designed to have the contents of the carts tipped directly into it, and provided, when necessary, with a screen or grid to prevent bulky articles from passing into the lower hopper. Between the two are doors which can be operated in any suitable manner other than that indicated on the plans. The function of the lower hopper is simply to regulate the quantity of refuse that will fall on the hearth, and to prevent too much being delivered at one time. Its capacity approximates one cubic yard, and it is furnished with suitable doors.

The normal working capacity of a plant of six cells is one hundred and twenty tons of refuse per day of twenty-four hours, or about 11,200 pounds per hour, and in times of pressure it is believed that one hundred and fifty tons per day can be disposed of. Assuming that one pound of refuse will evaporate from one pound to one and one-half pounds of water, the steam- producing capacity of this plant will range from 11,200 pounds to 16,800 pounds per hour on the one hundred and twenty tons per-diem basis, or from 560 tot 840 i.h.p. per hour.

X.

## LIST OF INSTALLATIONS OF THE "MELDRUM SIMPLEX" REFUSE DESTRUCTOR.

| Town. | Size of Plant. | Uses. |
|---|---|---|
| Darwen | 2 Four-Grate Units | Electricity Works |
| Hereford | 2 Two-Grate Units | Sewage Pumping |
| Hunstanton | 1 Two-Grate Unit | Water Pumping |
| Rochdale | 2 Four-Grate Units | Fertilizer Factory |
| Shipley | 1 Four-Grate Unit | Mortar Factory |
| Lancaster | 2 Four-Grate Units | Mortar Factory |
| Manchester | 12 Fryer Cells fitted with Meldrum Forced Draft and Grates | General Purposes |
| Mexborough | 1 Three-Grate Unit | |
| Nelson | 1 Four-Grate Unit | G'n'l M'n'p'l Work |
| Nuneaton | 1 Three-Grate Unit | Municipal Work |
| Radcliffe | 1 Three-Grate Unit | Sewage Pumping |
| Burton | 1 Two-Grate Unit | |
| Grays | 1 Two-Grate Unit | |
| Dalmarnock, Glasgow | 2 Three-Grate Units and 1 Two-Grate Unit | General Purposes |
| Houghton Main Colliery | 2 Two-Grate Units | Colliery Engines |
| Wrexham | 1 Four-Grate Unit | Electricity Works |
| Garston | 1 Three-Grate Unit | Electricity Works |
| Great Central Railway | 1 Two-Grate Unit, specially prepared for Wagon Department Refuse | |
| Heywood | 1 Two-Grate Unit | Sewage Pumping |
| Woolwich | 3 Four-Grate Units | Electricity Works |
| Sheerness | 1 Two-Grate Unit | Water Pumping |
| Lytham | 1 Two-Grate Unit | Sewage Pumping |
| Annandale, Sydney | 1 Two-Grate Unit | Sewage Pumping |
| Cleckheaton | 2 Two-Grate Units | Electricity Works |
| Walker-on-Tyne | 2 Four-Grate Units | |
| Withington | 2 Two-Grate Units | Sewage Pumping |
| Burnley | 1 Four-Grate Unit | Electricity Works |
| Glasgow, Crawford St. | 2 Three-Grate Units and 1 Two-Grate Unit | |
| Elland | 1 Three-Grate Unit | Electricity Works |
| Ayr, N. B. | 1 Six-Grate Unit | Electricity Works |
| Ipswich | 1 Four-Grate Unit | Electricity Works |
| Weymouth | 2 Two-Grate Units | Sewage Pumping |
| Watford | 1 Four-Grate Unit | Sewage Pumping |

| | | |
|---|---|---|
| Hyde | 2 Three-Grate Units | Sewage Pumping |
| Port Glasgow | 2 Two-Grate Units | Electricity Works |
| Dartford | 1 Two-Grate Unit | Electricity Works |
| Sudbury | 2 Two-Grate Units | Sewage Pumping |
| Kettering | 1 Two-Grate Unit | |
| Johannesburg, S. A. | 2 Four-Grate Units | |
| Holyhead | 1 Two-Grate Unit | Electricity Works |
| Preston | 4 Four-Grate Units | |
| Smerwick | 4 Four-Grate Units | |

And several installations in hospitals, industrial works, etc., etc.

LIST OF "BEAMAN AND DEAS" INSTALLATIONS.

Leyton, Sewage Works.
Colne, Electricity Works.
Christchurch, N. Z.
Llandudno, Electricity Works.
Canterbury, Electricity Works.
Bolton, Sewage Works.
Dewsbury.
Kingston-on-Thames, Sewage Works.
Bangor, Electricity Works.
Toowomba, Queensland.
Fleetwood, Electricity Works.
St. Helens, Electricity Works.
Streatham.
Rotherhithe.
Wimbledon, Electricity Works.
Stretford.

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## XI.

## ELECTRICAL POWER FROM REFUSE.

Of the one hundred and sixty places in Great Britain where destructors have been installed forty-five utilize the heat for the production of electric power. The actual capacity of the destructors adopted in combination with generating stations is upward of 1,400 tons of refuse per day. The electrical energy developed by the combustion of mixed town's refuse will average thirty British Board of Trade units per ton of waste destroyed. If it be assumed that each unit is equivalent to 280 candle power, then there is 8,400 candle power to be had from each ton of waste burned under these conditions. This is 11,760,000 candle power, equivalent to three hundred and ninety-two thousand Edison lamps of 30 candle power each.

## XII.

## RESIDUUM: ITS VALUE AND USES.

The ashes resulting from the incineration of municipal refuse possess a value which should be taken into account. When separated garbage is destroyed under high temperature there remains about 10 per cent. or two hundred pounds for each ton.

An analysis made at the Agricultural Experiment Station at Amherst, Mass., from two large samples of ash of separated garbage gave the following results.

| | Sample | |
|---|---|---|
| | No. 1. | No. 2. |
| Moisture at 100 C | .53 | 1.02 |
| Total phosphoric acid | 10.21 | 7.16 |
| Soluble phosphoric acid | None | None |
| Reverted phosphoric acid | 2.34 | 1.85 |
| Insoluble phosphoric acid | 7.87 | 5.31 |
| Potassium oxide | 6.01 | 5.68 |
| *Nitrogen | .17 | —— |
| Calcium oxide (lime) | 20.22 | —— |
| Magnesium oxide | 1.16 | —— |
| Ferric and aluminum oxides | 9.32 | —— |
| Sodium oxide | 15.65 | —— |
| Sulphuric acid | 4.57 | —— |
| Chlorine | 4.75 | —— |
| Carbonic acid | 10.85 | —— |
| Insoluble matter | 24.26 | 32.56 |
| Potassium oxide soluble in water | 4.65 | —— |

*Nitrogen was in form of cyanides. No nitrates or ammoniates were present.

The value of these ashes is approximately $3 to $5 per ton, according to the market for fertilizers. They must be kept covered from the weather and screened from foreign matter. Ashes of combustible refuse are worthless for purposes of fertilization. The ordinary destructor ash produced under conditions which guarantee perfect combustion is manufactured into brick, tile, paving blocks and other forms of building materials when ground and mixed with a percentage of cement or hydraulic lime, or it is made into concrete brick, which, when properly seasoned, is nearly 50 per cent. stronger than the ordinary building brick and can be manufactured at a lower cost and in far less time.

For the purpose of filling streets, walks, etc., destructor ashes are better than loam or gravel, as they harden, or pack, under travel and moisture.

## XIII.

## SPECIAL FEATURES OF DISPOSAL AND SANITARY WORK.

The Morse-Boulger Destructor Company is prepared to deal with waste disposal and sanitary engineering work in whatever way it may be presented.

### A PORTABLE REFUSE DESTRUCTOR

will sometimes be of great service in thinly settled localities, or where a large number of persons are temporarily brought together, and it might not be advisable to build a permanent disposal station.

This company can supply a thoroughly tested and efficient portable furnace that will destroy in a perfectly sanitary way from four to six tons of waste daily, which can be moved with rapidity from place to place, and may be made to supply a small amount of steam power if desired. Special details, description and cost will be furnished upon application.

### A SPECIAL EXCREMENT INCINERATOR,

for use in isolated private dwellings, schoolhouses, factories, summer resorts, etc., where sewage facilities are not available, has been perfected and brought into practice. This is a portable fire-closet, easily installed and connected with any chimney or available smoke-pipe. They are durable in construction, moderate in first cost and inexpensive in operation.

### A MUNICIPAL STEAM STERILIZATION PLANT

should always be a part of the sanitary equipment of the larger towns and cities. During epidemics there are often large quantities of infected articles destroyed which might be saved through proper disinfecting methods, and the value of this material annually destroyed will in many cases more than defray the cost of a sterilization equipment.

Since steam is the proper agent for disinfection, and is the chief item of expense in the construction of a plant, the combination of a disinfecting station with a destructor provides economical employment of the surplus steam of which the city can well take advantage.

The largest steam sterilizing plant in this country was designed and installed under the direction of the members of this company, and has been in operation in New York City for six years.

The Morse-Boulger Company will submit designs and estimates for the installation of steam sterilizing apparatus in connection with the destructor furnaces, or separately, and will assume the responsibility for the construction and successful operation of the same.

### A CREMATORIUM, OR MORTUARY FURNACE,

for the incineration of human bodies was designed and installed under the direction of members of this company ten years ago. There have been marked advances in this branch of the art since that time, and a far more powerful and improved type of incinerators that can be relied upon to fill all requirements can now be constructed.

## XIV.

## NOTES TO CORRESPONDENTS.

We are constantly in receipt of inquiries on many subjects connected with the collection and disposal of waste of every character. Although in each case particular, these inquiries cover very nearly the same ground, and the following notes in answer to correspondents will be found of service in the preliminary investigations of almost every class of inquirer.

The average American town produces approximately the following amounts of municipal waste, calculated in percentages of weight: Garbage, 12½ per cent. to 15 per cent.; ashes, 65 per cent. to 76 per cent.; rubbish, 8 per cent. to 12 per cent. These three items comprise practically all the municipal waste collected, as it is only in the larger cities that street sweepings are included in the waste.

In estimating quantities it is customary to allow from one-half of a pound to two-thirds of a pound of garbage per capita per day. This, of course, is dependent upon many varying circumstances and conditions, but as a general rule one-half of a pound will represent the normal quantity. For refuse and all combustible rubbish about one ton for every 10,000 persons is the average daily production. Ashes are a very uncertain quantity, depending upon the kind of coal used, whether natural gas is employed in the district of collection, and whether there is a good collection service. In a general way the average quantity of ashes may be said to be twenty tons per day for each ten thousand of the population. The general character of residences and the occupations of the inhabitants are also factors in the determination of the kind and quantites of each class of waste.

The reduction method of treating garbage deals only with market and kitchen offal, and recovers from this the grease and a "tankage," which is said to be valuable to use as a filler in manufacturing fertilizer. In comparison with cremation this process has these disadvantages—that the cost of reduction machinery is very great, that it treats only one-tenth part of the waste of the community (whereas cremation treats the whole) and the work must be done at a point far removed from the neighborhood of residences, because of the offensive odors thrown off. This entails large expense for the transportation of the waste, which expense must be borne by the city.

The facts appear to be that no reduction company can profitably conduct its business unless it is paid a bonus by the city greater than the amount that would be paid for its disposition by fire, either by the city or by private contractors.

There is very insistent purpose just at present on the part of speculative companies and private individuals to secure from towns and cities contracts for a term of years for the garbage collection and dis-

posal. They seek to influence communities by promises of organization of local companies formed upon capital raised in the town itself, which companies are expected to enjoy the enormous profits which it is predicted will result from the work done according to their methods.

These are purely stock jobbing operations, and are based upon speculation in the shares of prospective companies. For instance, a company in New England, last year, deluged the country with prospectuses containing misleading statements and the most adroit misrepresentations of general facts connected with the work of garbage disposal possible to hold out to a confiding public. It promised very great returns to the stockholders, but these promises have as yet failed to materialize. The company has not even built the initial plant in a New England city which was to demonstrate their process of utilization. Several cities that were reported as having made contracts with this company are awaiting fulfillment of the promises made them. The results of such fiascos are to destroy confidence and beget distrust of the statements of those who are really seeking to perform creditable work under conditions which shall be advantageous to both contracting parties.

Again, there have been failures in the performance of the garbage crematories that were built with small knowledge of what was demanded by the work, and with still less regard for sanitary conditions. They have all failed, as they deserved to do. Several now operating and claiming efficiency and unobjectionable performance are the subjects of investigation and charges of nuisance, and defendants in legal proceedings based upon these shortcomings.

It has taken a long time and a great many thousand dollars to discover that garbage can only be imperfectly burned when it is lying upon grates or bars which are made of piping and filled with water. Since the temperature of the grate can at the highest be little more than 212 degrees, the garbage brought in contact with it slowly distills, giving off noxious gases and odors, and is practically worthless for purposes of fuel.

Retrogression in the work of garbage disposal, as indicated by the abandonment of cremating furnaces in the last ten or twelve years has very nearly kept pace with the construction of furnaces, and if any real progress is to be made in the future it must be upon different lines, under better engineering advice, with more attention paid to details of construction, efficiency, economy and sanitation in operation, and under stringent contracts which provide for the best possible work, with severe penalties in case of failure.

Reference has been made to the fact that many cities and towns prefer to let this matter pass out of their hands into those of a contractor for a term of years for a stated sum. This is placing a premium upon having work done badly. No contractor handling city garbage will collect more than he is obliged to, nor will he be over-anxious to avoid nuisance in doing the work if it cost him money to do so. The result of this contract system is that the city gets its work done at a lower price, but at the expense of a great amount of friction between the contractor and the authorities, and often with serious prejudice to the health and comfort of the people.

Another and more serious error is made when the municipality makes a concession or gives consent for a contractor to collect and dispose of the waste, with the rights or implied power to charge a fixed sum per capita or for each household. This creates trouble in the amount of assessment and the collection of the tax, which is always very much larger than would be the case if the city did the work and paid for it by a pro rata tax upon the property valuation. The householder frequently declines to give the waste to the city's agent, and deals with outside parties. The result is disaster to the contractor. In four instances where this method has been tried it has failed, and in one case bankrupted the company holding the concession.

The collection and disposal system should be part of the city's work. There should be strict responsibility somewhere, and this can be had only by holding the officials of a community to account. If a city can operate and own its fire, water and sewage disposal works, its gas and electric lighting plants, and carry these on with its own officials, there is every reason that waste collection and disposal—a matter that directly affects the comfort and health of the public—should be conducted by the city, and not be allowed to pass out of its control.

A comparison of the contract and municipal methods of garbage collection in twenty cities shows that by contract it costs 14 cents per capita per annum, and by the municipal method 22 cents per capita. About 19 cents per capita per annum may be taken as the cost of effective collection of garbage.

The expenses of operating a disposal plant depend upon the costs of labor and fuel. The best well-authenticated example of the cost of operating a furnace of the American type in this country comes from Norfolk, Va., where a destructor of the old Engle type, built ten years ago by members of this company, has been in constant use up to the present date. Reports gathered from the official returns of the City Engineer show that 60,000 tons of garbage and refuse have been destroyed in ten years, at the cost of 50 cents per ton for fuel, labor and all repairs. The latter include the relining of the interior once, and the rebuilding twice of the steel chimney.

The most successful example of the use of petroleum oil as fuel for garbage disposal work was at the World's Fair in Chicago in 1893, where crematories built by members of this company destroyed the sewage sludge and the garbage resulting from the presence of twenty-seven millions of people in six months' continuous operation. These furnaces were on the grounds in close proximity to the great exhibition buildings and were completely sanitary and efficient in operation. They were awarded the highest medal in the gift of the Exposition.

It is not practicable to estimate closely in advance upon the cost of operating a disposal plant, and proposals are usually made dependent upon a maximum cost for operating based upon the local cost for fuel and labor. Most destructor builders are willing to give a maximum cost for operating in the preliminary estimates, which is rarely exceeded in actual work.

The time required for the erection of a disposal plant is from sixty to ninety days, unless unusual difficulties interfere. When the location

selected requires piles to be driven, or rock excavated, or other unusual difficulties in obtaining foundation are encountered, due allowance must be made for delays.

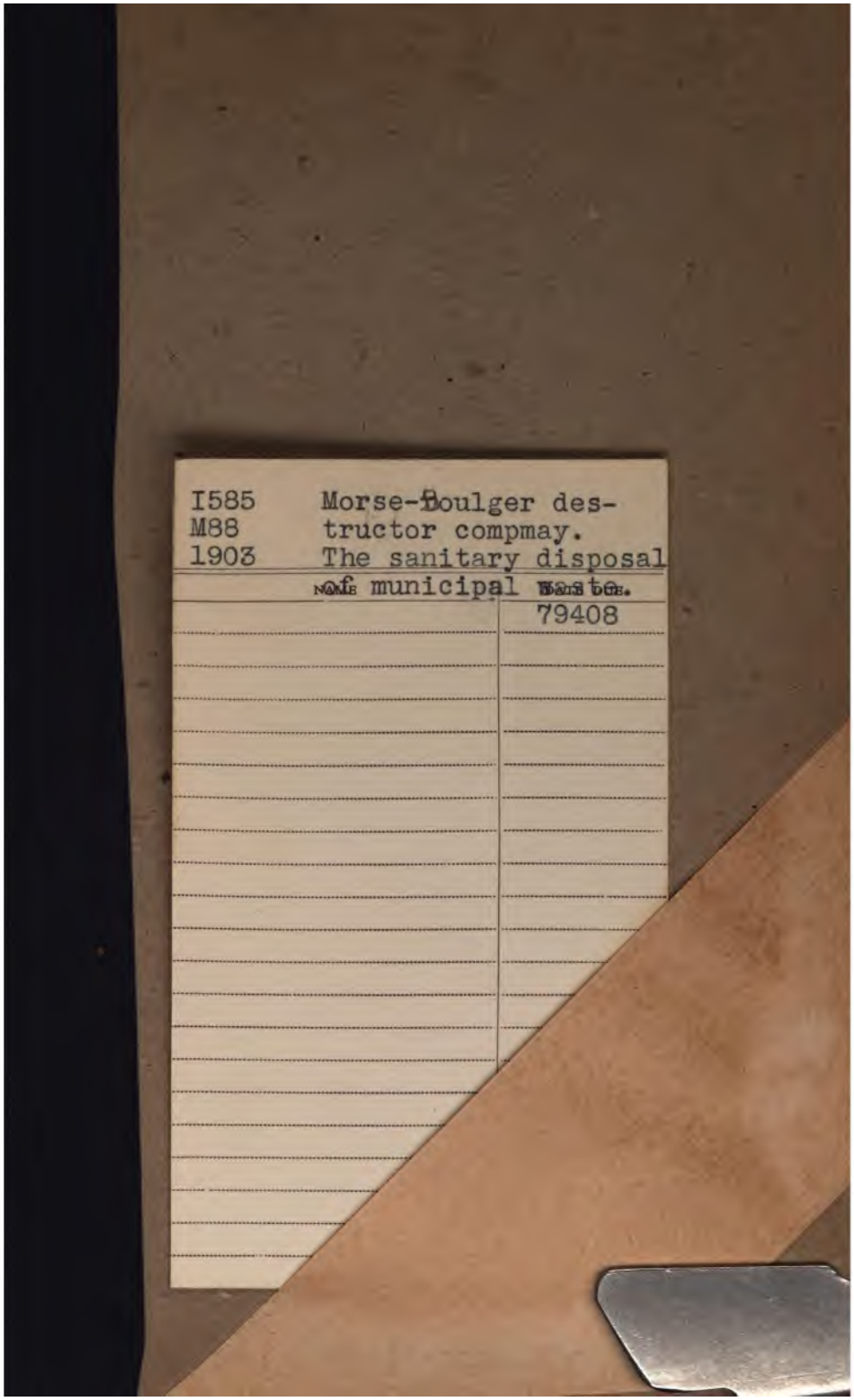
In selecting sites it is advisable to have the destructor located where a sidehill of eight to fifteen feet can be had, so that the top of the furnace can be reached by collection carts at a moderate ascent on the natural incline of the ground. This permits handling the refuse largely by gravity, as the disposal plant can be designed to operate altogether from one side, or from one end and one side.

The location should be as nearly as possible near the center of the city's collection district. It should be removed from the thickly settled portion of the town or city, and placed preferably on the northern side.

The chief cause of complaints against a garbage disposal plant is the constant passage of the collection carts and their presence during the discharge of their contents at the plant. This, of course, is unavoidable, as the work must be done in this manner, and the location of the destructor should be in proximity to the collection district in order to insure short hauls.

When it is remembered that moving one ton of garbage one mile in a cart, drawn by one horse, attended by one man, is estimated to cost 40 cents, then it will be seen that a saving can be effected if the distance of transportation is reduced to the lowest terms. A double-horse team with two men costs 75 cents per mile.

The science of garbage disposal is not wholly perfected. The difficult problems connected with it are very many, and they are perhaps more vexatious than those met with in other departments of municipal work. Only by patient study of local conditions, and by the use of reliable and successful methods, shown by good work under similar conditions, can wholly satisfactory results be attained.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